1

An Inexhaustible Source of Power

In 1894, as the First Sino-Japanese War loomed on the horizon, a young Sun Yat-sen, then just twenty-eight years of age, wrote a passionate petition to Li Hongzhang, the most prominent official associated with the Self-Strengthening movement in the final decades of the Qing era. In his letter, Sun implored Li to enact reforms in crucial areas such as education, agriculture, technology, and transportation. In particular, he emphasized the importance of technology, foretelling the arrival of the electrical age and its boundless potential. Sun wrote, "Recently, a revolutionary new method has emerged – the harnessing of the power of waterfalls to generate and store electricity, an inexhaustible source of power that can be used at any time and any place."[1] In a period when the country still relied overwhelmingly on the manual labor of its people, some enlightened Chinese figures, like Sun, began to envision a future in which alternative energy production would play a crucial role in shaping the nation's future.[2]

Sun Yat-sen's prophetic words, referring to a "new method of producing an inexhaustible source of power," have come to fruition as what we know today as hydroelectricity. The utilization of waterpower, however, is by no means a novel concept. In ancient Europe, for example, watermills powered by the natural force of flowing water had become an

[1] Sun Yat-sen, "Shang Li Hongzhang shu" 上李鸿章书 (June 1894), in *Sun Yat-sen quanji* 孙中山全集, vol. 1 (Beijing: Zhonghua shuju, 1981), 12.

[2] On the Qing empire's exploitation of natural resources, see Peter Lavelle, *The Profits of Nature: Colonial Development and the Quest for Resources in Nineteenth-Century China* (New York: Columbia University Press, 2020).

integral part of daily life. These watermills, which converted the power of water into mechanical force, relieved countless people of the grueling and monotonous task of grinding grains. The following epigram from the *Anthology* speaks to this revolutionary change:

> Spare your hands, which have been long familiar with the millstone, you maidens who used to crush the grain. Henceforth you shall sleep long, oblivious of the crowing cocks who greet the dawn. For what was your task, Demeter has now handed on to the Nymphs.[3]

William the Conqueror's 1086 Domesday Book survey reveals the presence of thousands of small water-driven mills in England and estimates that one mill existed for every fifty households.[4] However, the use of these mills was limited by environmental factors such as meteorology, topography, and geology. The mills primarily performed essential tasks such as producing grist, sawing, carding, and fulling, all crucial for the agricultural society of the time. For over a millennium and a half prior to the invention of the steam engine in 1769, water-powered machinery represented the most advanced and widely utilized mechanical technology in human society.[5] Even after the dawn of the first Industrial Revolution and its increasing reliance on fossil fuels, waterpower remained an important source of energy in Europe and the Americas. In the 1820s, the people of Lowell, Massachusetts, sought to overcome seasonal fluctuations in waterpower capacity by constructing a complex system of hydraulic works: Large masonry dams and protective walls, networks of distribution canals equipped with water gates and spillways, and upstream storage reservoirs. This was the first successful experiment in overcoming the physical and natural limitations of waterpower and stabilizing its output for the operation of mills. As a result, Lowell was transformed into the first "factory town" and the center of the textile industry in North America.[6]

[3] Nymphs is a metaphor for machine motor power. Marc Bloch, *Land and Work in Medieval Europe*, trans. J. E. Anderson (Berkeley: University of California Press, 1967), 145.

[4] Margaret T. Hodgen, "Domesday Water Mills," *Antiquity* 13 (1939), 261.

[5] See Lynn White, Jr., *Medieval Technology and Social Change* (Oxford: Oxford University Press, 1962); Jean Gimpel, *The Medieval Machine: The Industrial Revolution of the Middle Ages* (London: Penguin Books, 1976).

[6] Louis C. Hunter, *A History of Industrial Power in the United States, 1780–1930*, Vol. 1: Waterpower in the Century of the Stream Engine (Charlottesville: University Press of Virginia, 1979), 113. Also see Theodore Steinberg, *Nature Incorporated: Industrialization and the Waters of New England* (Cambridge: Cambridge University Press, 1991).

What was the experience of waterpower in Chinese history? From the Han dynasty (206 BCE–220 CE) onward, people harnessed the power of water for a multitude of purposes. The watermill played a crucial role in processing grain for the agricultural economy, also powering the development of tea and textile workshops, enabling the development of a commodity economy in certain regions.[7] However, the "new method of producing an inexhaustible source of power" that Sun Yat-sen spoke of in his letter and that is now known as hydroelectricity was first developed in Europe. My extensive examination of primary sources from the late nineteenth and early twentieth centuries reveals a nuanced perspective on the dissemination of hydroelectric knowledge in China. While the story of hydroelectricity may initially seem to fit within the conventional narrative of the transfer of Western science and technology to China, a

[7] On the development of watermills in Chinese history, see Joseph Needham, Ling Wang, and Gwei-djen Lu, *Science and Civilization in China*, *vol. 4, Physics and Physical Technology, Part II: Mechanical Engineering* (Cambridge: Cambridge University Press, 1965); Zhang Baichun 张柏春, "Zhongguo chuantong shuilun jiqi qudong jixie" 中国传统水轮及其驱动机械 (China's Traditional Waterwheel and Its Motor Mechanism), *Ziran kexue shi yanjiu* 自然科学史研究 (*Studies in the History of Natural Sciences*) 13, no. 2 (1994), 155–163; Tan Xuming 谭徐明, "Zhongguo shuili jixie de qiyuan, fazhan jiqi zhongxi bijiao" 中国水力机械的起源、发展及其中西比较研究 (A Study of the Origin and Development of Hydraulic Machinery in China and Its Comparison with the West), *Ziran kexue shi yanjiu* 自然科学史研究 (*Studies in the History of Natural Sciences*) 14, no. 1 (1995): 83–95; Li Bozhong 李伯重, "Chucai Jinyong: Zhongguo shuizuan dafangche yu Yingguo Arkwright shuilifangshaji" 楚才晋用: 中国水转大纺车与英国阿克莱水力纺纱机 (The Talent of Chu Put to Use by Jin: China's Water-Powered Spinning Wheel and Britain's Arkwright Water Frame), *Lishi yanjiu* 历史研究 (*Historical Studies*) 1 (2002), 62–74; Liu Xiaoping 刘小平, "Tangdai shiyuan de shuinianai jingying" 唐代寺院的水碾硙经营 (The Management of Buddhist Temples' Watermills during the Tang Dynasty), *Zhongguo nongshi* 中国农史 (*Chinese Agricultural History*) 4 (2005), 44–50; Wang Lihua 王利华, "Gudai huabei shuilijiagong xingshuai de shuihuanjing Beijing" 古代华北水力加工兴衰的水环境 (The Water Environment and the Evolution of Waterpower Use in Ancient North China), *Zhongguo jingji shi yanjiu* 中国经济史研究 (*Chinese Economic History Studies*) 1 (2005): 30–39; Nien Chen-ho 粘振和, "Lun Bei Song shuimo chafa" 论北宋水磨茶法 (The Study of the Monopoly System of Tea by Water-Powered Mills in the Northern Song Dynasty). 成大历史学报 (*Cheng Kung Journal of Historical Studies*) 47 (2014), 1–28; Fang Wanpeng 方万鹏, "Xiangdi zuomo: Mingqing yilai Hebei Jingjing de shuilijiagongye – jiyu huangjingshi shijiao de kaocha" 相地作磨: 明清以来河北井陉的水力加工业 – 基于环境史视角的考察 (Install Watermills According to the Terrain: The Hydraulic Machining in Jingxing of Hebei Province since the Ming and Qing Dynasties: Based on the Perspective of Environmental History Studies), *Zhongguo nongshi* 中国农史 (*Chinese Agricultural History*) 3 (2014): 51–58; In the Japanese-language literature, see Nishiijima Sadao 西 嶋定生, *Tyuugoku Keizaisi Kennkyuu* 中國經濟史研究 (Tokyo: Tokyo Daigaku shuppan-kai, 1966), chapter 4. This book has been translated into Chinese as *Zhongguo Jingjishi Yanjiu* (Beijing: Nongye chubanshe, 1984).

closer examination reveals more complex dynamics.[8] This chapter argues that the development of hydropower in China was not simply a straightforward replication of the Western experience but rather a process of adaptive appropriation. This involved the adaptation of hydroelectric principles to the features of local communities, environmental factors, and the prevailing political situation in the country.

This chapter undertakes a dual exploration of the early development of hydropower in China. On the one hand, it provides an intimate look at the experiences of three local elites who built small hydroelectric plants in southwest China. On the other, it describes the transformation of Chinese elites' understanding of China's hydropower potential, from initial skepticism to an eventual recognition of abundance. In the context of a persistent national crisis, many Chinese elites began to see hydropower as a key component in the project of building a strong, self-sufficient nation that was free from foreign aggression. The co-occurrence in the early twentieth century of the spread of hydroelectric knowledge and technology from the West and Chinese elites' search for means of national strengthening created a unique opportunity for the flourishing of both forces. The recognition of the potential of China's abundant hydropower resources promised a bright future for the nation. Thus, the seed of a hydropower nation was planted and awaited nurturing in the decades to come.

THE RISE OF "WHITE COAL"

During the Industrial Revolution, the rise of fossil fuels overshadowed the use of waterpower, which until then had been limited to locations near streams and rivers and was best suited to areas with waterfalls. Despite this shift, a lineage of hydraulic engineers continued to refine the waterwheel, the cornerstone of waterpower technology, and to increase its efficiency. In 1837, the French engineer Benoit Fourneyron, building on the research of Claude Burdin, invented the turbine, a revolutionary new type of waterwheel. Capable of producing 2,300 revolutions per minute with 80 percent efficiency and 60 horsepower, the turbine was a significant improvement in waterpower technology. The challenge of transmission remained. In 1895, at Niagara Falls, the Fourneyron turbine was put into use, converting waterpower into electricity on a massive scale for the

[8] See Benjamin A. Elman, *On Their Own Terms: Science in China, 1550–1900* (Cambridge, MA: Harvard University Press, 2005).

first time in history. This breakthrough, coupled with the development by Nikola Tesla in the late 1880s of a poly-phase alternating current system of generator, motor, and transformer, made long-distance transmission possible and ushered in the new era of hydroelectricity.

In the second half of the nineteenth century, major technological advancements in hydroelectricity occurred, primarily in Europe and North America, but then quickly spread to the East through transnational networks of missionaries.[9] In 1868, the American missionary W. A. P. Martin made a notable contribution to this transmission of knowledge. As a teacher and interpreter for the Translation Bureau in Beijing, Martin wrote *Introduction to Science* (*Gewu Rumen* 格物入门), a comprehensive textbook on Western science. In the section on water, Martin highlights a type of waterwheel referred to as the "watermill horizontal wheel" (*shuimo wolun* 水磨卧轮), which is in fact the Fourneyron turbine. He explains the principle of its operation in clear and concise terms: "Water is directed into the wheel's rim through a ten-foot-long vertical penstock. The wheel is fitted with curved buckets, which cause it to rotate as the velocity of the water drives it. The longer the penstock, the greater the power and speed of the wheel's revolution."[10] At the beginning of the twentieth century, the American missionary Young J. Allen began reporting on the hydropower projects at Niagara Falls in the *Chinese Globe Magazine*. Further, in 1898, the editorial board of *Scientific Review*, a journal published in Shanghai, in response to a question from a reader about the importance of waterpower relative to other sources of energy, acknowledged the benefits of waterpower but also acknowledged its limitations with respect to China. They noted, "There are only a few waterfalls in China, making waterpower less viable than wind power. It would be more advantageous if we could develop steam power, which surpasses waterpower in ease of use."[11] Despite China's long history of using watermills, the conventional wisdom of the time saw the country as lacking in hydropower potential.

By the early twentieth century, Europe and North America were undergoing two major scientific and technological advancements that would pave the way for the widespread use of hydroelectricity.

[9] On the evolution of hydropower technology in the West, see Norman Smith, *Man and Water: A History of Hydro-Technology* (London: Peter Davies, 1976).

[10] W. A. P. Martin 丁韪良, *Gewu Rumen* 格物入门 (*Introduction to Science*) (Beijing: Beijing tongwenguan, 1868), 27.

[11] *Gezhi xinbao* 格致新报 (*Scientific review*) (1898) 近代中国史料丛刊三编第24辑 (Taipei: Wenhai chubanshe, 1987).

https://doi.org/10.1017/9781009426589.003 Published online by Cambridge University Press

In addition to the turbine, hydraulic engineering was developed further to stabilize and maximize the energy-producing capacity of water, while the invention of alternating current made long-distance transmission of electricity a reality.[12] These technological innovations made hydropower more accessible and sustainable than coal-powered electricity, leading to a boom in its use in Europe and North America in the years following World War I. According to a 1934 census of installed electricity capacity in several major countries, hydropower dominated the energy mix in countries such as Canada, Italy, Norway, Sweden, and Switzerland, accounting for over 90 percent of total capacity. France and Japan also had substantial shares of hydropower, at 70 and 85 percent, respectively, while in the United States, Germany, and the Soviet Union the shares were 45, 40, and 20 percent, respectively.[13] In certain areas, such as Lowell in North America and the Alpine region in Europe, hydropower had become the primary source of electricity for industrial production and daily illumination. The term "white coal" initially referred to the glacial streams flowing down from mountains, but had by this period become synonymous with hydropower, reflecting its increasing importance and its equivalence to coal, if not yet its superiority.[14]

As the demand for energy continued to grow, people started to acknowledge the limitations of coal as a source of power. The burning of coal produced ash that contaminated the air and, as a finite resource, it could not meet the increasing energy needs of society forever. In contrast, hydropower was seen as a clean and renewable alternative, offering a promising future for modern industrial civilization. In the early twentieth century, the feeling among many was that the trend of industrialization was moving toward hydro-electrification.[15]

As Shellen Wu illustrates in her work, the exploitation of natural resources, such as coal mines, has long been intertwined with issues of state power and sovereignty.[16] In the early decades of the twentieth

[12] See Hunter and Bryant, *History of Industrial Power in the United States*.

[13] Huang Yuxian 黄育贤, "Zhanhou kaifa woguo shuili ziyuan zhi guanjian" 战后开发我国水力资源之管见, *Jingji jianshe jikan* 经济建设季刊1, no. 4 (1943), 42–47. Matthew Evenden, *Allied Power: Mobilizing Hydro-Electricity during Canada's Second World War* (Toronto: University of Toronto Press, 2015).

[14] For the study of the rise of "white coal" in Europe, see Landry II, "Europe's Battery."

[15] Lu Weizhen 陆为震 "Zhongguo weilai zhi shuili jianshe" 中国未来之水力建设 (China's Hydropower Construction in the Future), *Hankou Shangye Yuekan* 汉口商业月刊 1, no. 8 (1934), 21.

[16] Wu, *Empires of Coal*, 197.

century, China's resistance against imperialist invasions, particularly the incursions of the Japanese military, fueled a surge of nationalism. In their pursuit of economic development and political independence, Chinese elites saw it as their duty to harness the full potential of their nation's resources, including harnessing the energy of its rivers through the generation of hydropower. Their goal was not only to reconstruct and improve robust local economies but also to forge a strong, sovereign nation that could compete and succeed on the global stage.

In the early years of hydropower development, the presence of waterfalls was felt to be essential. As China lacked large waterfalls, many believed that its potential for hydropower was limited. However, with the advent of hydro-engineering, particularly with improvements in the construction of dams and penstock, perceptions of China's hydropower potential changed dramatically. Advances in hydrology and scientific studies of rivers further fueled this shift, as engineers and stakeholders grew increasingly optimistic about the prospects for hydropower in the country. According to the National Resources Commission of the Nationalist government in the late 1930s, China was estimated to have a potential hydropower capacity of over 40 million kilowatts, which would rank it as the third largest producer in the world, after only the United States and Canada.[17] This new recognition of China's hydropower potential served as a foundation for the confidence of Chinese civil engineers in the importance of hydropower in the country's state-building efforts. In Shanghai, for example, a quarter of the city's power plants were under foreign control and relied heavily on petroleum as their primary energy source.[18] However, this dependence on imported petroleum was viewed as a threat to China's national sovereignty.[19] The belief that China had enormous potential for hydropower – as opposed to oil fields, which were understood to be limited – took hold among the interested public. As Lu Shiqian 卢世钤, a college student studying civil engineering in

[17] Zheng Youkui 郑友揆, Cheng Linsun 程麟荪, and Zhang Chuanhong 张传洪, *Jiu Zhongguo de Ziyuanweiyuanhui, 1932–1949: Shishi yu pingjia* 旧中国的资源委员会, 1932–1949: 史实与评价 (The National Resource Commission in Old China, 1932–1949: Historical Fact and Evaluation) (Shanghai: Shanghai shehui kexueyuan chubanshe, 1991), 86.

[18] Gu Yuxiu 顾毓秀, "Dianqi yu jianshe" 电气与建设 (Electricity and Construction), *Xinmin* 新民 8 (1931), 10.

[19] American Standard Oil company was one of the largest exporters of petroleum products to China before the Second Sino-Japanese War, see Sherman Cochran, *Encountering Chinese Networks: Western, Japanese, and Chinese Corporations in China, 1880–1937* (Berkeley: University of California Press, 2000), chapter 2.

Shanghai, put it: "We should build hydroelectric plants anywhere we can to power our factories. With a cheap energy supply, our products will be able to compete with foreign goods and keep profits in the country. If we have sufficient hydropower energy, we will be able to stop importing oil from abroad, bringing us far greater benefits!"[20] Lu was not alone in his concern for the future of China's energy industry and its place in the world. This economic nationalism, rooted in the logic of the self-strengthening movement of the late Qing period, persisted through the twentieth century and was evident not only in the movements against imported goods but also in the pursuit of energy self-sufficiency, with a focus on hydropower development.[21]

Since the outbreak of the first Sino-Japanese War in 1895, Japan had occupied the attention of Chinese intellectuals. The engineer Shan Yubin 单毓斌 visited a power plant in Japan and wrote about his experience for his fellow Chinese, lamenting,

> Alas! Japanese entrepreneurs have invested heavily in developing hydroelectricity for the sake of their nation, leaving us far behind. Our country has its own mountains and rivers, including the renowned Qutang and Ba Gorges. If we bring together capitalists and engineers, our nation can greatly benefit from exploiting its hydropower potential.[22]

Further, Japanese hydropower construction in Manchuria and Taiwan embarrassed many Chinese intellectuals. In 1924, Japan completed the Riyuetan 日月潭 Hydropower Plant in Taiwan with an installed capacity of 100,000 kilowatts, making it the largest in Asia at the time.[23] Despite the rapid growth of Japan's hydropower industry, it did not possess the technology to produce large generators and turbines and thus had to

[20] Lu Shiqian 卢世钤, "Shuili liyong yu guomin jingji" 水力利用与国民经济 (Hydropower Exploitation and National Economy), *Zhonghua Yubao* 中华月报 5 (1935), 6.

[21] Pan Junxiang 潘君祥, *Zhongguo jindai guohuo yundong* 中国近代国货运动 (National Products Movements in Modern China) (Beijing: Zhongguo wenshi chubanshe, 1996); Karl Gerth, *China Made: Consumer Culture and the Creation of the Nation* (Cambridge, MA: Harvard University Asia Center, 2003).

[22] Shan Yubin 单毓斌, "Kaocha Riben Dongjing diandeng huishe guichuan shuilifadiansuo jilue" 考察日本东京电灯会社桂川水力发电所纪略 (Visit to Japan's Tokyo Light Company Guichuan Hydroelectricity Plant), *Dianqixiehui Zhazhi* 电气协会杂志 8 (1914), 54–63, 56.

[23] "Dongyang diyi fadian gongshe (shuli fadian)" 东洋第一发电工事 (水力发电) (The Largest Hydroelectricity Plant in East Asia), *Dianqigongye Zhazhi* 电氣工业杂志 2, no. 2 (1924), 74.

import them from Germany and the United States.[24] This further fueled the sense of urgency among Chinese elites, who were concerned that their country's energy sector would lag far behind Japan's. It is not surprising, then, that many civil engineers would become advocates for the development of hydropower in the aftermath of the Japanese invasions.

However, the question of how China could most quickly catch up with Japan and the other industrial nations in energy production loomed large. Some Chinese people looked northward for a solution. The Soviet Union, with its experience of electrification and hydropower development, emerged as an attractive alternative model.[25] As people in China learned about the Bolshevik revolution, they learned not only Marxist ideology but also about the Soviet experience of electrification. Impressed by what they saw as the Soviet Union's rapid transformation from a weak and poor nation into a strong industrial power, some Chinese sought inspiration from it.

Chen Zudong 陈祖东 was a civil engineer who graduated from Tsinghua University in 1935. He was also a cousin of Chen Guofu 陈果夫, who served as the minister of the Organization Department of the Kuomintang. In 1932, he lamented,

> China's abundance of population and natural resources, including the mighty Yangtze River, should have given it a distinct advantage in supporting industrialization. Yet, the lack of a unified plan for economic construction and the ongoing wars between warlords have left the Chinese people to suffer. In contrast, the leaders of the Soviet Union display a pragmatic attitude, leading to its rapid growth and rising influence among world powers. It is a source of shame for the Chinese people to lag so far behind despite their wealth of resources![26]

During his visit to the Soviet Union in 1939, Chen wrote journals to record his experiences and was deeply impressed by the Soviet Union's central planning and authoritarian capacity to force state policies through to completion, which he believed had led to the rapid growth of industrial

[24] On the building of large hydropower projects in the Japanese empire, see Aaron Moore, *Constructing East Asia: Technology, Ideology, and Empire in Japan's Wartime Era, 1931–1945* (Stanford: Stanford University Press, 2015).

[25] For studies on the electrification of Russia, see Anne D. Rassweiler, *The Generation of Power: The History of Dneprostroi* (Oxford: Oxford University Press, 1988). Jonathan Coopersmith, *The Electrification of Russia, 1880–1926* (Ithaca: Cornell University Press, 1992). On Chinese views of Soviet Russia, see John Knight, "Savior of the East: Chinese Imagination of Soviet Russia during the National Revolution, 1925–1927," *Twentieth Century China* 43, no. 2 (2018), 120–138.

[26] Chen Zudong, "Su'e jianshe zuida shuilifadianchang" 苏俄建设最大水力发电厂 (Soviet Union Builds the Largest Hydroelectricity Plant), *Su'e Pinglun* 苏俄评论 5 (1932), 616.

production in Russia. He suggested that China should adopt the Soviet model to develop its energy sector.[27]

Many in China were aware of the close relationship between energy production and a country's global standing as they observed the experiences of electrification in industrial countries such as Japan and the Soviet Union. They understood that an underdeveloped country like China needed a comprehensive national plan and a competent, if not authoritarian, government with strong executive power if it was to advance on this front. By the mid-twentieth century, hydropower, despite its unfamiliarity to many, had become a crucial indicator of national competence. As Chen Zudong put it, the construction of hydropower capacity should be embraced without hesitation as "the formula for China's national reconstruction."[28]

LOCAL PIONEERS

Despite this change in the consciousness of certain elites, before 1935 the use of hydropower in China was limited to a few scattered localities.[29] Western scientific theories of hydroelectricity were introduced by foreign missionaries and progressive Chinese intellectuals, but it was Chinese entrepreneurs who put the knowledge into practice. They viewed the construction of hydropower plants as a sound investment, a "once and for all" source of power that would have long-term or even permanent benefits. Upon learning about the construction of hydroelectricity plants at Niagara Falls in the United States and Canada, some Chinese businessmen expressed amazement at the apparently endless benefits that such a project could offer: "How could the benefits ever be exhausted?"[30]

YAOLONG 耀龙 AND JIHE 济和

In the early years of China's interactions with foreigners in the late Qing and early Republican periods, local businessmen were the primary supporters of hydropower development. As Elisabeth Koll has shown, the construction of railroads in China involved extensive collaboration

[27] Chen Zudong 陈祖东, "Cong dianlishuili shuodao Sulianjianguo yu Zhongguojianguo" 从电力水力说到苏联建国与中国建国 (From Electricity, Hydropower to the Construction of Soviet Union and China), *Xinjingji* 新经济 2, no. 4. (1939), 88.

[28] Chen, "Cong shuilidianli shuodao Sulianjianguo yu Zhongguojianguo," 91.

[29] For electric power output in China before 1937, see Tim Wright, "Electric Power Production in Pre-1937 China," *The China Quarterly* 126 (1991), 356–363.

[30] Shangyuan 商原, *Shangwubao* 商务报 31 (1908).

between foreigners and Chinese.[31] Indeed, this transformative infrastructure project played an important role in the development of China's first hydropower project. In 1897, France was granted permission to build a railway connecting Haiphong in Vietnam and Kunming in Yunnan province, but this sparked an intense negative reaction in Kunming.[32] In May 1900, a Catholic cathedral was burned down and the religious leaders of all the Christian denominations in the city were forced to flee.[33] Despite the turmoil and upheaval, a tiny Anglo-French business community persevered. To provide power for the railway station that was then under construction, a French survey team proposed the construction of a hydropower plant along the winding course of the Tanglang River 螳螂川 in Yunnan. This river was the sole outlet of the massive Dian Lake 滇池 and flowed for over 360 kilometers before merging with the Jinsha River 金沙江 to the north. The steep terrain and the lake's potential as a natural reservoir promised an ample supply of hydropower.[34]

While the French celebrated their own railway as a project "worthy of the genius of the French,"[35] many Chinese businesspeople saw it as a threat to their commercial interests and to China's larger national interests. These businesspeople believed that the exploitation of hydropower was an "economic benefit and a political right of the Chinese nation and people."[36] With the aim of harnessing the energy of the Tanglang River, Liu Lingfang 刘苓舫, the director of the Bureau of Business Promotion in Yunnan, proposed the establishment of a plant to be "jointly managed by officials and businesspeople." Despite his efforts, however, few

[31] Elisabeth Koll, *Railroads and the Transformation of China* (Cambridge, MA: Harvard University Press, 2019).

[32] On the history of Vietnam-Yunnan railroad, see Mi Rucheng 宓汝成, *Diguo zhuyi yu Zhongguo tielu, 1847–1949* 帝国主义与中国铁路 (*Imperialism and China's Railway, 1847–1949*) (Beijing: Jingji guanli chubanshe, 2007); Wu Xingzhi 吴兴帜, *Yanshen de pingxingxian: Dian-Yue tielu yu bianmin shehui* 延伸的平行线: 滇越铁路与边民社会 (*Extended Parallel Lines: The Dian-Vietnam Railway and the Borderland Community*) (Beijing: Beijing daxue chubanshe, 2012).

[33] Robert Nield, *China's Foreign Places: The Foreign Presence in China in the Treaty Port Era, 1840–1943* (Hong Kong: Hong Kong University Press, 2015), 288.

[34] Yunnan Sheng difangzhi bianzuan weiyuanhui 云南省地方志编纂委员会, Yunnan Sheng zhi. juan 1, Di li zhi 云南省志-卷一地理志 (Yunnan Province Magazine: Roll 1, Geography Section) (Kunming: Yunnan renmin chubanshe, 1998), 300–301.

[35] Gabrielle Vassal, *In and Round Yunnan Fou* (London: W. Heinemann, 1922), 33.

[36] Zheng Qun 郑群, *Zhongguo Diyisuo Shuidianzhan Shilongba Chuanqi* 中国第一座水电站石龙坝传奇 (*The Legend of China's First Hydroelectric Plant: Shilongba*) (Kunming: Yunnan jianyu chubanshe, 2012), 16.

businessmen showed interest in the project.[37] Undeterred, the Kunming Chamber of Commerce stepped in and petitioned the local county magistrate to allow them to raise funds among themselves to build the hydropower plant. Under the leadership of Wang Xiaozhai 王筱斋, the owner of a private bank, a joint-stock corporation called the Kunming Yaolong Light Company was established to manage the construction and operation of the plant.[38] With the help of private investment and local initiative, the first hydroelectric plant in China, the Shilongba 石龙坝, was finally completed and brought into operation in Kunming in 1910 (Figure 1.1).[39]

Despite the nationalist motivations behind the project's inception, the Kunming Yaolong Light company had no choice but to seek technical support and machinery from foreign sources.[40] Through the mediation of Carlowitz & Company, a German trading firm with an office in Shanghai, the electrical equipment and turbines were provided by Siemens and Voith, respectively. The latter also dispatched two engineers to help with the design and construction. By 1912, the Yaolong Company had constructed a 1.478-kilometer canal and installed 480 kW of electrical equipment, ready to provide power to Kunming.[41] This was a pioneering project in China in another way, as it was the first to utilize high voltage alternating current (23,000 V) to transmit electricity over the relatively long distance of 35 kilometers to downtown Kunming.

[37] In the nineteenth century, the Qing state assumed very limited responsibility for infrastructure and industrial development. See Madeleine Zelin, *The Merchants of Zigong: Industrial Entrepreneurship in Early Modern China* (New York: Columbia University Press, 2006).

[38] Local gentry-merchants and chambers of commerce were active and played a leading role in local societies in the nineteenth and early twentieth century China, see Susan Mann, *Local Merchants and the Chinese Bureaucracy, 1750–1950* (Stanford: Stanford University Press, 1987); Prasenjit Duara, *Culture, Power, and the State: Rural North China, 1900–1940* (Stanford: Stanford University Press, 1991); Ma Min, *Guanshang zhi jian: shehui jubianzhong de jindai shenshang* 官商之间:社会巨变中的近代绅商 (*Between Official and Merchant: The Modern Gentry-Merchants amid Drastic Social Change*) (Tianjin: Tianjin renmin chubanshe, 1995); Elisabeth Koll, *From Cotton Mill to Business Empire: The Emergence of Regional Enterprises in Modern China* (Cambridge, MA: Harvard University Asia Center, 2003).

[39] See Arunabh Ghosh, "Multiple Makings at China's First Hydroelectric Power Station at Shilongba, 1908–1912," *History and Technology* 38 (2022), 167–185.

[40] On the Sino-German relationship and trade, see William Kirby, *Germany and Republican China* (Stanford: Stanford University Press, 1984).

[41] "Shangban Yunnan Yaolong diandeng gongsi Shilongba gongcheng jilue" 商办云南耀龙电灯公司石龙坝工程纪略 (Brief Records of the Commercial Yunnan Yaolong Company Shilongba Project), *Zhongguo Shuilifadian Shiliao* 中国水力发电史料 (*China Historical Materials on Waterpower*) 1 (1987), 73.

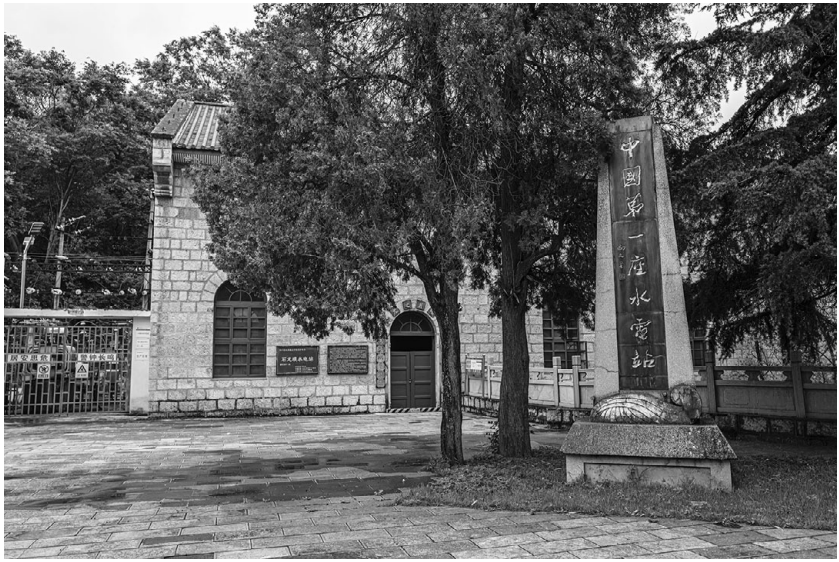

FIGURE 1.1 Shilongba Hydropower Plant (Photo by zhouyousifang/Moment via Getty Images)

The introduction of electric light in Kunming was initially met with skepticism and resistance. Despite the technical advancement that the Shilongba Hydropower Plant represented, the inconsistent and sometimes unstable supply of power was a major hindrance to the widespread adoption of electricity. Every night, just before 10:00 pm, light bulbs in the city would dim to a mere "glow of incense sticks," and residents would use their kerosene lamps for light.[42] Further, the plant's output exceeded the initial market demand. But the Yaolong Company did not give up on its mission to bring the benefits of electricity to the people of Kunming. They undertook a concerted effort to advertise the advantages of electric light and installed light bulbs for free to entice potential customers. These efforts paid off and the operation of the company soon became viable. Four months after its inauguration, more than 3,000 lamps had been sold. Seven local mills and factories began to use electricity as their primary source for driving equipment as well as illumination.[43] By 1923, the

[42] Frank Dikötter, *Exotic Commodities: Modern Objects and Everyday Life in China* (New York: Columbia University Press, 2006), 136.

[43] "Yunnan fu, Zhongguo de diyige shuidianzhan" 云南府, 中国的第一个水电站, 西门子杂志 (China's First Hydropower Plant), *Zhongguo Shuilifadian Shiliao* 5 (1989), 70–72. Before the employment of ammeters, electric companies sold electricity according to the wattage of light bulbs.

https://doi.org/10.1017/9781009426589.003 Published online by Cambridge University Press

growing demand for electricity compelled the company to expand its installed capacity to meet the new needs of the community. The Shilongba Hydropower Plant thus played a pivotal role in the electrification of Kunming and the surrounding areas.

Following the success of the Yaolong plant, another hydropower project – named Jihe – was established in 1925 along the Longxi 龙溪 River in Luzhou 泸州, Sichuan. The Jihe project was designed by a talented civil engineer, Shui Xiheng 税西恒, who was born in Luzhou and had received training in mechanical engineering in Germany. After working briefly for Siemens, Shui returned to Sichuan and served as the director of the Southern Sichuan Construction Bureau.[44] With his professional training and local connections, Shui was able to convince local merchants and officials to invest in a hydroelectric plant that would harness the hydropower of the Longxi River. A curved masonry dam, standing 2.5 meters tall and stretching 80 meters across the river, was built to control water for the generation of electricity. The equipment required for the project, including a turbine and a 140-kW generator, was imported from Germany.[45] In the construction of the Shilongba and Jihe projects, a unique solution was found to overcome the problem of a shortage of cement, and a sticky rice slurry was used as a substitute.[46] In Nanping 南平, Fujian province, meanwhile, Ji Tinghong 纪亭洪, a member of the local gentry, used an indigenous wooden water wheel to drive a generator, thus providing an early example of blending traditional knowledge and local materials with advanced engineering technology.[47] These innovations and experiments, much like Eugenia Lean's study of "vernacular industrialism," show that the development of

[44] Liu Shengyuan 刘盛源, *Shui Xiheng zhuan* 税西恒传 (*Biography of Shui Xiheng*) (Beijing: Tuanjie chubanshe, 2016).

[45] Yang Yongnian 杨永年, "Jianguoqian Sichuan de shuidian jianshe" 建国前四川的水电建设 (Hydropower development in Sichuan before 1949), *Zhongguo shuilifadian shiliao* 2 (1987), 44–45.

[46] On the production of cement in China, see Albert Feuerwerker, "Industrial Enterprise in Twentieth-Century China: The Chee Hsin Cement Co," in *Approaches to Modern Chinese History, ed.* Albert Feuerwerker, Rhoads Murphey, and Mary C. Wright (Berkeley: University of California Press, 1967), 304–342; Wang Yanmou 王燕谋, *Zhongguo Shuini Fazhanshi* 中国水泥发展史 (*The History of Cement in China*) (Beijing: Zhongguo jiancaigongye chubanshe, 2005); Micah Muscolino, "Energy and Enterprise in Liu Hongsheng's Cement and Coal-Briquette Business, 1920–37," *Twentieth-Century China* 41, no. 2 (2016), 159–179; Humphrey Ko, *The Making of the Modern Chinese State: Cement, Legal Personality, and Industry* (Singapore: Palgrave Macmillan, 2016).

[47] Nanpingshi difangzhi bianzhuan weiyuanhui 南平市地方志编纂委员会, (eds.), *Nanping diquzhi* 南平地区志 (*Gazetteer of Nanping*) (Beijing: Fangzhi chuabanshe, 2004).

hydroelectricity in China was not solely a transfer of Western technology but rather a process that involved adaptation, local expertise, and practical experience.[48] These factors are often overlooked in current narratives of hydropower engineering.

FUYUAN 富源

During the Second Sino-Japanese war (1937–1945), the picturesque town of Beibei 北碚, located 60 kilometers north of the bustling city of Chongqing, became a kind of sanctuary for various institutions and offices of the Kuomintang government, universities, merchants, and others. Beibei was situated along the banks of the Jialing River, providing convenient transportation to Chongqing despite heavy bombing in the area by the Japanese. The river featured rapid currents and smooth, rounded rocks that stood above the water, which provided the inspiration for the town's name: "Bei" meaning north and "bei" meaning rock, or "Northern Rock." The town's three main streets were full of activity, especially on market days when farmers from the surrounding countryside arrived before dawn to sell their produce. The migration of the Nationalist government to the area in the early phases of the war had brought increased business and higher prices, and boats on the Jialing River brought additional goods to the town.[49] At night, the town was illuminated by flickering vegetable oil lamps, while restaurants and households awaited the arrival of electricity. When it finally arrived, according to one observer, "suddenly there was a universal 'Ah!' and claps of hands and believe it or not, it was the electricity!"[50] Even in wartime, Beibei was an important hub of commerce and community.

The demand for energy in Beibei, including electricity, skyrocketed with the arrival of industries from elsewhere and the growth of the refugee population. The town's municipal authority had already built a coal-fired power plant to provide electricity to the district, but its capacity was insufficient to meet rising demand brought on by the war. Furthermore, coal was a precious resource and was earmarked by the government for powering munitions factories, which were prioritized during the war.

[48] Eugenia Lean, *Vernacular Industrialism in China: Local Innovation and Translated Technologies in the Making of a Cosmetics Empire, 1900–1940* (New York: Columbia University Press, 2020).

[49] Adet Lin, Anor Lin, and Meimei Lin, *Dawn over Chungking* (New York: The John Day Company, 1941), 54.

[50] Lin et al., *Dawn over Chungking*, 32.

It was against this backdrop that Lu Zuofu 卢作孚, the director of the shipping company Minsheng 民生 (People's Livelihood), proposed the construction of a hydropower plant on the Liangtan 梁滩 River at Gaokengyan 高坑岩 to support the growing refugee community.

In fact, the idea of harnessing the energy of the Liangtan River for generating electricity had been in Lu Zuofu's mind since 1933. He saw the potential of the river and its waterfalls and, despite facing initial financial challenges, submitted an application to the local government and sent engineers to survey the river in that year.[51] He was not alone in that idea, as the renowned educator and rural reconstruction activist Yan Yangchu 晏阳初, better known in English as Jimmy Yen, also saw the potential of the waterfalls and established the China Rural Construction College near Beibei in 1940 because of its proximity to this resource.[52] It was not until the latter stages of the Second Sino-Japanese war in 1943, however, that the rising demand for energy in the refugee-rich town of Beibei, combined with support from the Water Conservancy Commission, the Communication Bank, Jincheng Bank, and other local entrepreneurs, finally provided Lu with the opportunity to make his idea a reality. He relaunched his hydropower plan and established the hydroelectric company Fuyuan, meaning "source of wealth."

The Liangtan River originated in the towering peaks of Bi Mountain in Sichuan province and eventually converged with the Jialing River near Beibei. This river had tremendous potential for the production of hydroelectricity. The rapids at Gaokengyan, where the river plummeted 40 feet, were an excellent location for a hydropower plant. While hydroelectricity is attractive in terms of its affordability once facilities have been built, it requires substantial upfront investment. Thus, the Fuyuan Company, like many other small-scale hydropower plants, used a joint-stock system to

[51] Guanyu qingjiang gaokengyan huafen jiexian beian bing fentou zai Shanghai dinggou jiqi zhi Tao Jianzhong de tongzhi 关于请将高坑岩划分界限备案并分头在上海订购机器致陶建中的通知 (A Notice to Tao Jianzhong for Registration of the Demarcation of Gakengyan and Ordering Appliances in Shanghai) (February 17, 1933), 02070006000510100013, Chongqing Municipal Archives (hereafter CMA), Chongqing. On Lu Zuofu's contributions to the modernization of Beibei, see Zhang Jin 张瑾, *Quanli, Chongtu yu Biange: 1926–1937 nian Chongqing Chengshi Xiandaihua Yanjiu* 权力、冲突与变革：1926–1937 年重庆城市现代化研究 (*Power, Conflict and Reform: A study of the Modernization of Chongqing, 1926–1937*) (Chongqing: Chongqing chubanshe, 2003), chapter 6.

[52] Yan Yangchu 晏阳初, *Pingmin jianyu yu xiangcun jianshe yundong* 平民教育与乡村建设运动 (*Civilian Education and Rural Construction Movement*) (Beijing: Shangwu yinshuguan, 2014), 287.

raise the necessary funds. With an initial share capital of 20 million yuan, consisting of 20,000 shares of 1,000 yuan each, the company attracted a diverse array of investors.[53] At their first meeting, the founders elected Lu Zuofu as chair of the board of directors. Lu's company, Minsheng, took on the task of manufacturing the hydro turbines required for the project itself, setting it apart from other companies like Yaolong and Jihe who imported their turbines from abroad. This was a testament to Lu's commitment to bringing the vision of this project to life. The establishment of Fuyuan was made possible by the combined efforts of a number of influential figures who brought with them not only financial resources but technical expertise as well. As a joint-stock enterprise, the company aimed to provide electricity for both domestic and commercial purposes, including household lighting and power for small and middle-sized factories. Reports estimated that when Fuyuan was built Beibei already had around 600 light bulbs, averaging 15 watts and powered by coal. However, with their confidence in the potential of hydroelectricity, the founders of Fuyuan believed they had the capacity to power another 3,000 bulbs.[54] The future of the company seemed promising.

A NEW MAN-MADE DISASTER

Chris Courtney has elegantly explained that floods are the result of a complex interplay of natural forces and human interference.[55] Throughout Chinese history, human actions have altered the landscape and waterways, and the creation of concrete dams and the implementation of hydropower technology have only enhanced our ability to manipulate rivers. The Liangtan River had tremendous hydropower potential but its flow was unpredictable, fluctuating greatly depending on the amount of rainfall in the area. To ensure a stable flow and the presence of enough water to generate electricity consistently throughout

[53] Fuyuan shuili fadian gongsi faqiren xingming jingli ji rengu shumu 富源水力发电公司发起人姓名经历及认股数目清册 (List of names, profiles and committed share amounts of Fuyuan hydroelectric company initial founders), 00600002001440000002, CMA, Chongqing.

[54] Fuyuan shuili fadian gufen youxian gongsi chuanli huiyilu ji diyi, er, sanci dongjian lianxi huiyi jilu 富源水力发电股份有限公司创立会决议录及第一、二、三次董监联席会议记录 (Fuyuan Hydroelectric Power Company, Ltd. founding meeting resolution records and the first, second and the third board of directors meeting records) (June 2, 1943), 02200001000027000, CMA, Chongqing.

[55] Courtney, *Nature of Disaster in China*.

the year, a dam had to be constructed upstream from the power plant. Unfortunately, this led to conflict between the local community and the power company.

The Liangtan River had been used as a source of mechanical power for decades but not by the hydropower company. A number of watermills were in operation along the river, processing grain for local communities. The construction of the dam, however, caused the water level to rise and disrupted the operation of the watermills. Low-lying areas along the river were also flooded for the first time. To mitigate the negative impacts, the company built a lower dam with a sluice gate to regulate the water level in case of emergencies.[56] The company also implemented strict regulations for the use of the sluice gate. Despite these efforts, the reservoir still submerged farmlands, bridges, and roads. To address this, the company raised the height of bridges and roads to maintain accessibility, but it could not prevent the submerging of farmlands whose owners it had to compensate. To gain the support of local communities, the company reached out to local leaders and security groups. Jiang Gengqiao 蒋耕樵, the town chief of Xinglongxiang 兴隆乡, was supportive and saw supporting the nation's development efforts as a duty of local societies. He recommended two members of the local gentry, Lü Siqi 吕思齐 and Liu Yingzhou 刘瀛洲, to the company as advisors, as he believed they not only appreciated the value of the hydropower project but were also well-acquainted with the local situation.[57]

Lü Siqi, however, owned one of the watermills that had been impacted by the dam. His millhouse was in danger of collapsing because of the rising water. He wrote a letter to the company's manager, expressing concern about the financial loss the dam had caused him.[58] The company

[56] Guanyu jiansong Gaokengyan shuili fadianchang Liangtanqiao mofang, xushuiba gongcheng jianshe jingguo qingxing ji gongcheng yingxiang zhoubian bing jinxing bujiu deng de cheng, han, daidian, ling 关于检送高坑岩水力发电厂梁滩桥磨坊、蓄水坝工程建设经过情形及工程影响周边 并进行补救等的呈、函、代电、令 (Reports, letters, telegraphs and orders on Gaokengyan hydropower plant reservoir project's impact on Liangtanqiao watermills and its surrounding area) (August 6, 1943), 022000010018500000001000, CMA, Chongqing.

[57] Xinglong was a township under Bishan county and was located on the upper stream of the Liangtan River. On rural social life and the changes it underwent during the war, see Isabel B. Crook, Christina K. Gilmartin, Yu Xiji, Gail Hershatter, and Emily Honig, *Prosperity's Predicament: Identity, Reform, and Resistance in Rural Wartime China* (New York: Rowman & Littlefield, 2013).

[58] Guanyu Baxian Xinglongxiang shangmin Lü Siqi, Wu Jicheng konggao Fuyuan shuilifadian gufen youxian gognsi lanjian fangwu, fanghai tongcheshuili bing banli peichang sunshi shiyi de cheng, han, daidian, xunling 关于巴县兴隆乡商民吕思齐、吴继澄控告富

promised to raise his watermills and compensate him for his losses, but months went by and nothing was done. Frustrated, Lü took further action. A heavy rainfall in 1946 resulted in accidental flooding of farmlands and watermills along the dammed river, further fueling local residents' dissatisfaction. Lü, as an influential member of the gentry, not only defended his own interests but also rallied local residents to protect their properties. He organized a petition delegation and brought their concerns to the public media, putting pressure on the hydropower company and local government to act.

In their petition, Lü and his followers referred to the flood as a man-made disaster and blamed it on the construction of the dam. They argued that the project posed a threat to public welfare, treated the local community unjustly, and undermined the efforts of resistance and reconstruction.[59] The hydropower company defended its project, claiming that the flood was an inevitable natural disaster that could have occurred regardless of the dam's construction. The company also emphasized in its response that the project was designed for the benefit of the public rather than for profit.[60]

The conflict surrounding the dam's construction highlighted the existence of differing perspectives on what "progress" entailed. Some saw the dam as a symbol of progress and believed it should be built, while others criticized its negative economic and ecological impacts on local society. It is important to understand that the development of hydroelectric projects is not a straightforward and simple process of progress, but a multifaceted one. In challenging the conventional modernist or developmentalist discourse that portrays the hydroelectricity project as solely positive, I aim to shed light on the diverse experiences of the different groups involved in and impacted by the project.

源水力发电股份有限公司滥建房屋、妨害筒车水利并办理赔偿损失事宜的呈、函、代电、训令 (Reports, letters, telegraphs and orders on merchants Lü Siqi, Wu Jicheng from Xinglong township, Ba county, who sued Fuyuan Hydroelectric Power Company, Ltd. for building infrastructure which harmed local water conservancy, and on the issue of compensation) (April 6, 1946), 02200001000660000001000, CMA, Chongqing.

[59] Baxian Liangtanhe liangan nongmin bei Fuyuan shuidian gognsi du chengzai qingyuantuan 巴县梁滩河两岸农民被富源水电公司堵□成灾请愿团 (Petition group of Ba county farmers along the Liangtan River whose lands were negatively affected by the disaster caused by the Fuyuan Hydroelectric Power Company) (April, 1946), 02200001000660000001000, CMA, Chongqing.

[60] Guanyu Baxian Xinglongxiang shangmin Lü Siqi, Wu Jicheng konggao Fuyaun shuilifadian gufenyouxian gongsi lanjian fangwu, fanghai tongcheng shuili bing banli peichang sunshi shiyi de cheng, han, daidian, xunling.

The conflict described here raises important questions about who has the right to use the river and what such a right entails. Traditionally, when disputes over access to water resources arose, individuals or families sought the help of respected members of the local gentry or government officials for mediation. These disputes were often resolved based on land rights and the chronological sequence of water use, but they sometimes escalated into inter-clan conflicts.[61] During the War of Resistance against Japan, the Kuomintang government prioritized the use of resources to support the war effort. To this end, in 1942, the government introduced the Shuili Jianshe Gangyao (Principles of Water Conservancy Construction), which emphasized the need to prioritize the demands of the war while ensuring the protection of water sources. The Principles stated that hydroelectric projects should be developed to the fullest extent possible, taking into account the specific industrial and social demands of the time.[62] It is clear that this conflict over the use of the river reflected the larger issue of who possessed the power to determine how natural resources would be used and developed. While the government's principles prioritized the needs of the war and reconstruction, it is important to consider the effects on local communities and the environment as well.

As a center of resettlement located near the wartime capital of China, Beibei faced a pressing need for a more stable energy supply. In light of this, elites residing in the area were highly supportive of the Liangtan River hydroelectric project, which appeared poised to receive a water-use permit from the local government. In 1943, the Ba County government dispatched engineers to assess the project and wrote an informal ruling

[61] On water management and water-rights disputes in Chinese history, see Purdue, *Exhausting the Earth*; R. Keith Schoppa, *Xiang Lake: Nine Centuries of Chinese Life* (New Haven: Yale University Press, 1989); Thomas M. Buoye, *Manslaughter, Markets, and Moral Economy: Violent Disputes over Property Rights in Eighteenth-Century China* (Cambridge: Cambridge University Press, 2000), chapter 3; Chao Xiaohong 钞晓鸿. "Guangai, huanjing yu shuili gongtongti – jiyu Qingdai Guanzhong zhongbu de fenxi" 灌溉, 环境与水利共同体 (Irrigation, Environment and Hydraulic Community: An Analysis based on the Central Part of the Guanzhong Plain), *Zhongguo Shehui Kexue* 中国社会科学 4 (2006), 190–204; Zhang Junfeng 张俊峰, *Shuili Shehui de Leixing: Ming Qing yilai Hongdong Shuili yu Xiangcun Shehui Bianqian* 水利社会的类型: 明清以来洪洞水利与乡村社会变迁 (*The Pattern of Hydraulic Society: Water Conservancy and Rural Social Changes in Hongdong since the Ming and Qing dynasties*) (Beijing: Beijing Daxue chubanshe, 2012).

[62] Tian Dongkui 田东奎, "Zhongguo jindai shuiquan jiufen jiejue jizhi yanjiu" 中国近代水权纠纷解决机制研究 (Study on the Mechanism of Solving Water Rights Dispute in Modern China), PhD Dissertation, Zhongguo Zhengfa University, 2006, 222.

that the company would secure its permit.[63] However, in 1947, due to the ongoing controversy surrounding the dam and the devastating flood of 1946, the company was yet to receive the permit.[64]

Despite the lack of a permit, the project was still completed, and electricity was generated for the town of Beibei starting in 1944. However, the lack of a permit was not the only challenge that the project faced. The natural flow of the river posed another challenge: The water level was subject to change, which affected the river's ability to power the turbines. The engineers had designed the dam with a sluice gate to regulate the water level and thereby ensure consistent power, but the company was unable to build a higher dam due to cost constraints and resistance from local residents. As a result, it was compelled to build a lower dam, which then led to periodic shortages of water for the turbines. During the driest months, the turbines could only run for ten hours per day, which resulted in a limited power supply for the town.[65]

The success of small hydroelectric projects in southwest China was conditioned by several factors. First, the region's topography, with its waterfall and steep river channels, provided ideal conditions for harnessing hydropower. Also, the availability of steel turbines and electric generators through international trade networks facilitated the implementation of these projects. As the central government in this period was weak and no comprehensive planning was possible, the driving force behind these initiatives was local business and political elites who sought to meet private and civic energy needs. In this context, the role of the state (represented by local officials) was limited to providing support and assistance.

[63] Guanyu Fuyuan shuili fadian gufenyouxian gongsi liyong Gaokengyan pubu jingying shuilifadian ji banli shuiquan dengji, kancha shiyi, jiansong shuiquan dengji shenqingshu deng de cheng,han,pi 关于富源水力发电股份有限公司利用高坑岩瀑布经营水力发电及办理水权登记、勘察事宜、检送水权登记申请书等的呈、函、批 (Reports, communications, and responses on the Fuyuan Hydroelectric Power Company using Gaokengyan waterfall to generate electricity and registration of water rights, investigation, and submission of application) (June, 1943), 022000010001100000002000, CMA, Chongqing.

[64] Fuyuan shuili fadian gufenyouxian gongsi di er jie di san, sidengci dongjian liangxihuiyi, gudong dahui jilu(fafang guxi,xiuzheng gongsi zhangcheng, zengjia ziben deng) 富源水力发电股份有限公司第2届第3、4等次董监联席会议、股东大会记录 (发放股息、修正公司章程、增加资本等) (The third and fourth board meetings of the Fuyuan Hydroelectric Power Company, Ltd., on interest distribution, revising company bylaws, and increasing capital) (October 24, 1947), 022000010000300000001000, CMA, Chongqing.

[65] Ibid.

CONCLUSION

From the beginning, China's hydroelectric enterprises relied heavily on the advanced technologies developed in Europe and North America. The first hydropower plant in China, Yaolong, was designed by German engineers and imported its major pieces of equipment from Germany. Despite their limited scope, these projects still had a significant impact on local communities. The process of adapting and incorporating new technologies into existing systems is an inescapable element of how the relationships between humans and the environment are shaped.[66] In the case of the Liangtan River project in Beibei, the construction of the hydropower plant submerged watermills and farmlands, resulting in a loss of access to water for the riverside community. At first, only the more affluent households and businesses in the town benefited from the project, not the farmers whose properties adjoined the river or people living near the dam and the plant.[67] Although the flood in 1946 was not necessarily caused by the dam, it further impacted the livelihoods of the local residents, who saw the dam as the cause of a man-made disaster. These small-scale projects, which negatively affected a relatively small number of people, nonetheless portended the environmental and social disruptions that would be occasioned by the rapid expansion of hydropower in the second half of the twentieth century. Despite this, the social implications of these projects are usually overlooked in current discussions of the early history of hydropower in China.

With the beginning of the electrical age in the late nineteenth century, China was slow to experience the major technological innovations that were transforming life elsewhere. Despite this, people in China responded quickly to the energy transitions and technological advancements coming from Europe and North America. The emergence of small hydropower plants in southwest China shows that early Chinese responses were not led by the state, which was in disarray at the time. Rather, they were driven by the initiative of private individuals and local elites. These local hydropower projects were fueled by a combination of resistance to foreign influence and a concern for China's status and prosperity during a tumultuous period. Although China could not be described as

[66] This is partially inspired by Nye, *Electrifying America*.

[67] Nicole Barnes, *Intimate Communities: Wartime Healthcare and the Birth of Modern China, 1937–1945* (Berkeley: University of California Press, 2018).

a hydropower nation in this period, certain Chinese elites recognized the potential to harness the country's hydropower resources as a means of securing its future. In response to the deepening national crisis caused by Japanese military aggression and the development of concrete mega-dams, technocrats serving in the Kuomintang government sought to harness the rivers in China's hinterland for the dual purpose of military resistance and national reconstruction.